Best Practice

BETWEEN THE LINES

Dietary management of type 2 diabetes mellitus

Nate Link
New York University
School of Medicine
New York, NY

Correspondence to:
natelink@aol.com

Mrs. Matthews was a 45-year-old obese nonsmoker with recent-onset type 2 diabetes. She referred herself to Dr. Drysdale because of dissatisfaction with control of her blood glucose, despite taking 10 mg of glyburide per day. Her glucose monitoring record showed fasting values consistently around 100 mg/dL but postprandial values that fluctuated markedly from 80 to 400 mg/dL. Upon additional questioning, she noted that the highest glucose values were related to large meals or binges of sweets following periods of restraint. She also reported that she had lost 20 pounds on 2 occasions by aggressive dieting but had immediately gained the weight back both times. Dr. Drysdale took note of the American Diabetic Association's recent nutritional guidelines[1] and considered these basic questions in his initial approach to dietary management of Mrs. Matthews' hyperglycemia.

How effective is weight loss in controlling blood glucose levels?

Of all dietary modifications, weight loss is perhaps the best documented intervention; a number of trials have shown that hypocaloric diets substantially reduce blood glucose. It is not clear, however, whether glucose improvement is related to weight loss per se or simply to the temporarily decreased caloric intake that takes place during the period of weight loss.

For example, when 30 diabetic subjects were fed a very low-calorie diet, 330 calories per day, for 40 days, the average glucose level decreased from 297 to 158 mg/dL.[2] Although 87% of this reduction occurred by day 10 of the diet, most of the weight loss took place in the subsequent 30 days. When subjects resumed isocaloric feedings, about half of the original glucose gain disappeared even though their original weight loss was preserved.

In a randomized trial comparing 2 diets in diabetic patients, subjects who lost an average of 24 pounds on a 400-calorie diet reduced their fasting blood glucose (FBG) by 104 mg/dL while those who lost the same amount of weight on a 1000-calorie diet reduced their FBG by 61 mg/dL.[3] When the first group switched to the 1000-calorie diet, their FBG climbed to match the second group, despite their losing an additional 15 pounds.

In a study of long-term effects of weight loss in 110 diabetic patients, the 6 subjects who maintained a 30-pound weight loss at 1 year experienced a decline in FBG from 186 to 109 mg/dL. The 20 subjects who lost 15 to 30 pounds had a decline from 191 to 162. The remaining 84 subjects (76%) experienced no discernible improvement in their FBG.[4] This study illustrates the main drawback to weight loss as a tool for glycemic control: most patients are simply unable to achieve and maintain their target body weight. Weight loss is, however, an effective strategy for glucose control for the few patients who are able to achieve it.

What are the benefits of spreading intake throughout the day?

One of the earliest known dietary principles is the advantage of frequent small feedings rather than several large meals. This common sense axiom is based on the principle that type 2 diabetics may retain an adequate insulin response to a modest carbohydrate load but are unable to cope with intakes above a certain threshold.

In a comparison of 2 versus 6 meals per day, the more frequent feedings reduced the daily amplitude of glucose swings (between highest and lowest) from 110 to 59 mg/dL and decreased the peak glucose by about 40 mg/dL but did not affect average glucose levels, because glucose lows were also attenuated.[5]

In a more extreme comparison, patients who took 17 hourly snacks per day experienced a 28% reduction in insulin levels but only a 4% reduction in average blood glucose, compared with subjects taking 3 meals per day.[6] In a recent small crossover trial, an isocaloric 12-snack-per-day diet decreased the average daily blood glucose from 200 to 173 mg/dL, in comparison to a 3-meal-per-day diet. The mean insulin level also decreased by 9.2%.[7]

The chief advantage of this practice, then, is to moderate blood glucose extremes and to reduce insulin secretion. Theoretical drawbacks to frequent feedings include the potential for weight gain and difficulty with compliance. The principle of frequent small feedings has never been tested in a large randomized trial to assess effectiveness and social acceptability. Spreading intake throughout the day with small meals and snacks dampens blood glucose extremes but has only modest effects on average glucose levels.

What is the proper intake of simple sugars and complex carbohydrates?

Traditional teaching in diabetic diets has favored starches over sweets. A considerable body of evidence has essentially contradicted this maxim, and there are currently no clear answers as to the appropriate composition of carbohydrates in a diabetic diet.

Between the Lines is a case-based review of commonly asked clinical questions. Responses to the questions will examine the "fine print" of the evidence in order to bring primary data about diagnostic and clinical efficacy directly to the reader. The objective in presenting this quantitative information is to encourage and empower clinicians to weigh risks and benefits in tailoring their clinical decisions to the needs of their individual patients.

Readers are invited to submit Between the Lines articles to be considered for publication by WJM to Nate Link, MD, c/o WJM, PO Box 7690, San Francisco, CA 94120-7690.

A prominent tool in this area of research has been the glycemic index, a standardized measure of blood glucose response to the ingestion of given substances. Lists of the glycemic index (GI) for most common foods have been reported in the literature and yield a number of surprises. For example, using white bread as a standard GI of 100, an equivalent carbohydrate content of honey yields a GI of 126; of sucrose, 86; of bananas, 79; of frozen peas, 74; and of ice cream, 52.[8]

These data are complicated, however, by the observation that when foods are ingested in mixed meals, the effects of fat and fiber on gastric emptying and intestinal absorption may produce unpredictable results. To test this effect, glycemic responses to 3 common foods (bread, rice, and spaghetti, with GIs of 100, 79, and 61 respectively) were tested in each of 12 diabetic subjects as 50-gram portions in otherwise identical mixed meals. The measured values were similar to the predicted effects (bread 100, rice 75, and spaghetti 54), with consistent responses among different subjects.[9] In another study, however, differences in the GI index overpredicted differences in glycemic responses to mixed meals.[10] The authors of the latter study have strongly cautioned the medical community against a wholesale adoption of the GI in dietary planning.[11]

A more recent trial pitted a traditional (high carbohydrate) diabetic diet against an isocaloric experimental diet that emphasized sucrose- and fructose-rich carbohydrates rather than usual starches such as bread and potatoes. The incremental glucose response to the experimental diet was only 3% that of the traditional diabetic diet.[12]

The chief dietary contributors to hyperglycemia are carbohydrates of all types. In general, sweets may be substituted for complex carbohydrates without harming glucose control. The glycemic index may become a useful tool for meal planning.

What is the appropriate lipid composition in a diabetic diet?

On first glance, a high-fat diet would appear to be the perfect solution to glucose intolerance. The risk of coronary artery disease, however, has led the ADA in the past to recommend strict controls in dietary fat intake and to emphasize carbohydrates as the chief energy source. Nonetheless, as recent data challenge blanket assumptions about the role of diet in lipid management, other approaches are gaining acceptance.

Of specific interest is the relationship between coronary risk and the types of fats that are consumed. For example, compared with a traditional high-carbohydrate diet, a high-monounsaturated fat diet (50% fat) decreased blood glucose by 14%, serum triglycerides by 25%, and insulin doses by 14%, without affecting LDL cholesterol or weight in type 2 diabetics on insulin therapy.[13]

In a follow-up study of 42 diabetics on glipizide therapy, the high-carbohydrate diet increased glucose, triglyceride, and insulin levels by 12%, 9%, and 10%, respectively, compared with the high monounsaturated fat diet.[14] Body weight and low- and high-density lipoprotein levels were unaffected. The long-term effects of the high monounsaturated fat diet have not been assessed by a large-scale randomized trial under "real-life" conditions. Regardless of total fat intake, diabetic diets should emphasize monounsaturated fats over other dietary sources of fat. Replacement of carbohydrates by monounsaturated fats may be considered in refractory cases, but weight and lipid profile should be closely monitored.

Taking notice of Mrs. Matthews' failure to sustain weight loss in the past and her acceptable fasting blood glucose, Dr. Drysdale focused on fluctuations in her postprandial values as they related to carbohydrate intake. He advised her to reduce the size and increase the time between meals, to eat small snacks, and to add sweets to her daily carbohydrate quota to avoid periodic cravings. He emphasized the value of monounsaturated fats but decided not to press for an increase in total daily fat intake. He referred Mrs. Matthews to a dietician for intensive instruction to integrate these principles into a modestly hypocaloric diet.

References

1 American Diabetes Association. Nutrition recommendations and principles for people with diabetes mellitus. Diabetes Care 1998;21(supp):S32-35.

2 Henry RR, Scheaffer L, Olefsky JM. Glycemic effects of intensive caloric restriction and isocaloric refeeding in noninsulin-dependent diabetes mellitus. J Clin Endocrinol Metab 1985;61:917-925.

3 Wing RR, Blair EH, Bononi P, et al. Caloric restriction per se is a significant factor in improvements in glycemic control and insulin sensitivity during weight loss in obese NIDDM patients. Diabetes Care 1994;17:30-36.

4 Wing RR, Koeske R, Epstein LH, et al. Long-term effects of modest weight loss in type II diabetic patients. Arch Intern Med 1987;147:1749-1753.

5 Bertelsen J, Christiansen C, Thomsen C, et al. Effect of meal frequency on blood glucose, insulin, and free fatty acids in NIDDM subjects. Diabetes Care 1993;16:4-7.

6 Jenkins DJA, Wolever TMS, Vuksan V, et al. Nibbling versus gorging: metabolic advantages of increased meal frequency. New Engl J Med 1989;321:929-934.

7 Jenkins DJA, Ocana A, Jenkins AL, et al. Metabolic advantages of spreading the nutrient load: effects of increased meal frequency in non-insulin-dependent diabetes. Am J Clin Nutr 1992;55:461-467.

8 Jenkins DJA, Wolever TMS, Jenkins AL, et al. The glycaemic response to carbohydrate foods. Lancet 1984;1:388-391.

9 Wolever TMS, Jenkins DJA, Vuksan V, et al. Glycemic index of foods in individual subjects. Diabetes Care 1990;13:126-132.

10 Coulston AM, Hollenbeck CB, Swislocki ALM, et al. Effect of source of dietary carbohydrate on plasma glucose and insulin responses to mixed meals in subjects with NIDDM. Diabetes Care 1987;10:395-400.

11 Hollenbeck CB, Coulston AM, Reaven GM. Glycemic effects of carbohydrates: a different perspective. Diabetes Care 1986;9:641-647.

12 Gannon MC, Nuttall FQ, Westphal SA, et al. Acute metabolic response to high-carbohydrate, high-starch meals compared with moderate-carbohydrate, low-starch meals in subjects with type 2 diabetes. Diabetes Care 1998;21:1619-1616.

13 Garg A, Bonanome A, Grundy SJ, et al. Comparison of a high-carbohydrate diet with a high-monounsaturated fat diet in patients with non-insulin-dependent diabetes mellitus. New Engl J Med 1988;319:829-834.

14 Garg, A, Bantle JP, Henry RR, et al. Effects of varying carbohydrate content of diet in patients with non-insulin-dependent diabetes mellitus. JAMA 1994;271:1421-1428.